FLUKA simulation of LHC BLMI response functions for different particles

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LHC-type beam loss monitors based on ionization chamber (LHC BLMI) are planned as beam loss detector for SIS 100 operation. This type of beam loss monitor has different response functions for various particle types. In this contribution FLUKA[1] simulations of the response functions for different types of particles are presented. In order to simulate a response function of the beam loss monitor, the model of BLMI was implemented in the Monte Carlo code FLUKA.

The BLMI consists of 60 parallel plate ionization chambers packed in a stainless steel cylindrical vessel with a 2 mm wall and covered on top and bottom by two stainless steel plates 5 mm and 4 mm thick respectively. The signal is created by collecting electron-ion pairs on a pile of 61 parallel aluminum electrodes with a thickness of 0.5 mm, diameter 75 mm and equally spaced by 5.75 mm. Electrodes are held by 6 stainless steel rods which are in turn fixed by insulating ceramic pieces. The volume of a detector is filled with nitrogen gas with overpressure of 100 mbar.

An ionizing particle deposits energy into the volume of BLMI and creates electron-ion pairs which are collected by electrodes. The minimum energy, which a particle needs in order to create an electron-ion pair, the so called W-factor, is 35 eV for nitrogen. The energy deposition was calculated by FLUKA in a sensitive volume between the electrodes and then converted into charge per primary simulated particle. The result is compared with simulations performed in Geant4 (version 8.0 patch-01) by CERN BLM group[2].

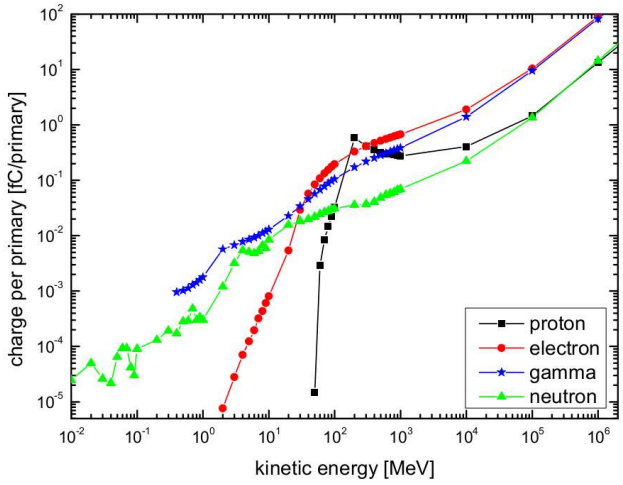

Figure 1: Response of the ionization chamber for particles impacting longitudinally to the detector axis.

Two series of simulations were performed depending on the impact direction of the beam: a longitudinal impact direction (the beam is uniformly distributed, parallel to the detector axis and has a circular cross section with a diameter of the detector) and transversal (the beam is uniformly distributed and has a rectangular cross section which is matched with a detector cross section). The response function was obtained for 4 types of particles: protons, electrons, gammas and neutrons in the range of 10KeV up to 1TeV.

The result of simulations is presented in Figures 1 and 2. The behavior of corresponding curves is similar for two different simulations. But the amplitude of the response functions in case of longitudinal irradiation is higher, because the large amount of material, traversed by the beam, generates a higher number of secondary particles. Both figures match the Geant 4 simulations which were cross checked with the experiment. These results are the base for further optimizations of the future SIS 100 Beam Loss Monitoring System.

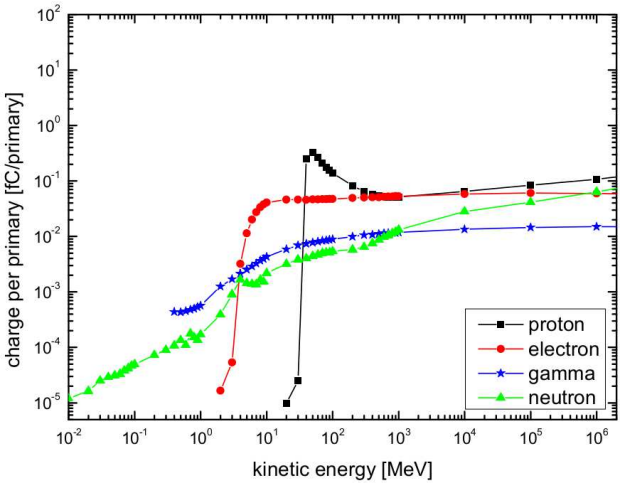

Figure 2: Response of the ionization chamber for particles impacting transversally to the detector axis.

References

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